



Objectives for Human Missions to NEOs

Operations Concepts

Presented by: Douglas Craig

11 August 2010



Day 2 – Ops Concept Brainstorming



- **From Day1 results, how should the tasks be performed?**
 - How should humans interact with the NEO? (directly, robotically, types of rendezvous and docking)
 - Mission operations
- **Will use mission phases to help focus on Concept of Operations Brainstorming**
 - At NEO (focus on this first)
 - In Transit
 - Earth Return
 - LEO and Preparation

Concept of Operations LEO



- Types of Operations at LEO
 - Assembly and checkout of integrated NEO exploration systems
 - Possible configuration
 - Core module (power, logistics, ECLSS),
 - 2 Space Exploration Vehicles (SEV)
 - Propulsion stages
 - One or two earth return vehicles
 - Advanced recon probe
 - Provisioning

Concept of Operations Outbound to NEO



- Types of Operations
 - Deploy simple probe for advanced recon (weeks to months prior to crew)
 - Identify size, spin, composition, local features, morphology
 - Allows for target modification for launch contingencies
 - In-flight Training
 - Have simulated NEO surface to practice NEO ops (rendezvous and docking, EVA, etc.)
 - Refine detailed flight plans prior to arrival
 - System monitoring, contingency EVAs
 - Microgravity / biological research, variable gravity, radiation monitoring, physiological/psychological



Types of Operations at NEOs

- Types of Operations
 - Human Spacecraft Ops
 - EVA Ops
 - Science Ops
 - Robotic Ops

Concept of Operations at NEO - Human Spacecraft Ops



- Far and near field surveys
 - Situational awareness / hazard characterization
 - Resource assessment
- NEO orbit insertion and station keeping
- Deployment of exploration vehicle
 - Mothership stays within sight and communication
 - Exploration vehicle operations
 - Anchoring/free flying/cable grid for translation
- Monitor spacecraft system performance
- Exploration vehicle rendezvous and dock with Mothership

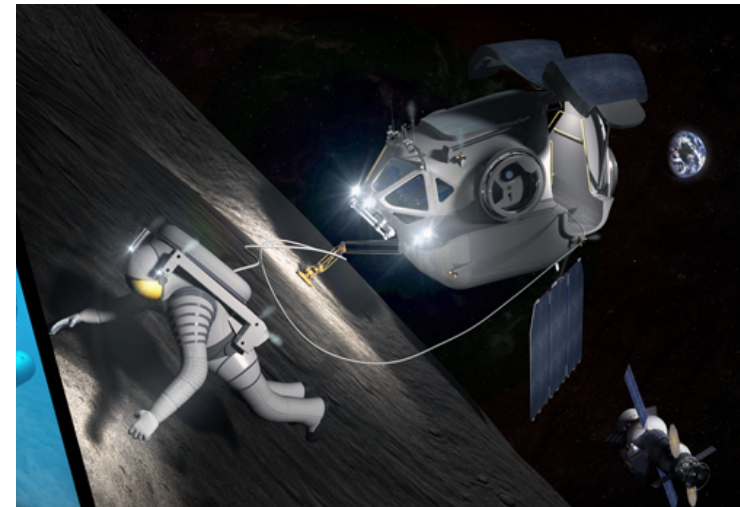


Concept of Operations at NEO

- EVA Ops



- Astronaut EVA to surface from Exploration vehicle
 - Astronaut fixed to NEO or Exploration vehicle
 - Translation system
 - Robotic arm
 - Excursion lines
 - Cable grid
 - Minimum EVA team is 2
 - IVA monitoring required



Concept of Operations at NEO

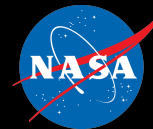
- Science Ops



- EVA crew does majority of science tasks with robotic assistance
 - Core sampling and deep drilling
 - Seismic surveying
 - Sample collection (bulk and selective)
 - ISRU demos
- Deployment and emplacement of packages
 - Seismic sensors
 - Tracking devices (transponders, reflectors)
 - NEO orbital modification techniques

Concept of Operations at NEO

- Robotic Ops



- Tele-robotic operations (prior to EVA, during and after EVA)
 - Aercam
 - Autonomous drilling
 - ISRU testing
- Leave behind robotic assets
 - Exploration Vehicle for continued teleoperations, communications for deployed systems, etc.

Concept of Operations Return to Earth



- Higrate and curate samples
- Operate and monitor robotic devices left behind at NEO
- Vehicle systems monitoring
- Life Science research
- Planetary defense experiments
 - NEO impactor (transit stage)
 - Seismic charge
- Crew psychological and physiological monitoring